

NOTES ON THE ARCHAEINAE AND OTHER RUSSULAS

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This paper comprises notes, including type studies, on a miscellany of russulas. In the taxonomic descriptions included, English color names are those of the ISCC-NBS system (Kelly & Judd 1955); the more precise “M&P” (Maerz & Paul 1950) designations are sometimes also given for spore colors. Spore size and shape were determined in lateral view; the recorded size excludes ornamentation. Spore ornamentation is described as it appears in Melzer’s reagent; its height is given as the range within which the highest ornamentation unit on any one spore falls. Other microscopic structures were studied either from tangential sections of a pileus (with lamellae attached) cut from the approximate midpoint of a pileus radius or from radial sections cut from the uppermost centimeter of the stipe. Basidium length as given excludes sterigma length. Subhymenium thickness was measured approximately halfway between the top and edge of the lamella. Specimens examined are deposited in MICH unless another *Index herbariorum* symbol indicates otherwise.

EVALUATION OF THE ARCHAEINAE

Some years ago when concentrating on the subsections *Compactae* and *Lactarioideae* of *Russula* sect. *Compactae*, I also studied three species then placed in another subsection, *Archaeinae*, of the same section by Singer (e.g., 1951). Bills and Miller (1984) recently published a modern description and illustrations of one of these species, the eastern North American *R. earlei* Pk., and it can now be considered well known. Notes on the other two species, known only from type specimens, follow.

Russula archaea Heim, Candollea 7: 382. 1938. *Russula archaea* Heim, Lactario-russulés Madagascar 68. 1938, without Latin description.—TYPE: “Ad terram, singularis, in prisca silva orientali. Madagascar, H. 49, 12 novembre 1934.” (holotype: PC!). Figs. 1–2.

Pileus 3 cm broad, irregularly plane with the margin decurved on one side. Lamellae broad (3–4 mm broad), thick, unequal, the lamellulae of varying lengths and common, but not alternating with the lamellae (lamellae ca 21 in number, lamellulae ca 13, 0–2 lamellulae between each pair of lamellae), ventricose, acute in front, usually squarely adnate, rarely slightly decurrent, markedly distant (1–3 mm apart at the pileus edge), neither forked nor intervenose, entire. Stipe 16 mm long, 5–7 mm thick, tapered to the base, glabrous, solid.

Spores 5.2–6.3 (–6.7) × 4.0–4.8 μm, broadly elliptic to broadly obovate or obovate, almost smooth; ornamentation less than 0.1 μm high, of small warts which are usually isolated, but occasionally united in clusters or short ridges or connected by fine lines, never forming a reticulum; suprahilar area a plage or with very faint

ornamentation in the same pattern as that on the remainder of the spore wall. Basidia $40\text{--}49 \times 6\text{--}8 \mu\text{m}$, clavate, usually 4-, occasionally 2-spored. Hymenial pseudocystidia $41\text{--}67 \times 3\text{--}5 \mu\text{m}$, narrowly subcylindric to narrowly fusiform, rounded apically, glassy or containing yellowish, often refractive granules, arising in the subhymenium or at the outer edge of the trama, embedded or projecting up to $9 \mu\text{m}$ beyond the basidioles, abundant (but inconspicuous). Subhymenium $40 \mu\text{m}$ thick, pseudoparenchymatous, the cells smaller than the tramal sphaerocysts. Trama lacking vascular hyphae, composed almost entirely of sphaerocysts in the lamellae, even near the lamellar edges. Pileus cuticle $120\text{--}133 \mu\text{m}$ thick, embedded in gluten, of horizontally oriented, nongelatinous, septate, branched hyphae $1\text{--}4 \mu\text{m}$ broad, some of which have scattered refractive granules.

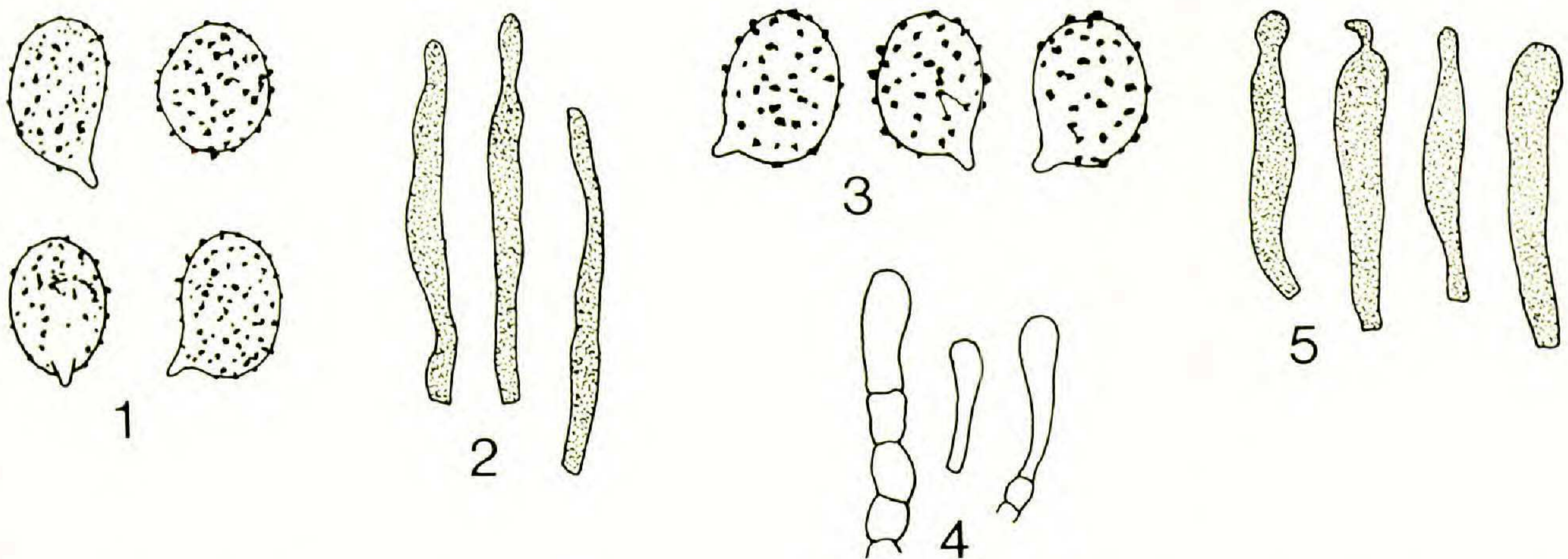
Solitary on soil in an ancient forest.

SPECIMEN EXAMINED. Madagascar. Fotsialana [Fotsiatanana, according to the collection label], vallée de l'Onibe, 12 Nov 1934, *Heim H49* (PC, holotype of *R. archaea* Heim).

The collection cited is a single pickled basidiocarp in good condition except now moderate brown overall, and the above description was drawn from it. The new species was first described, with illustrations, only in French; the Latin description validating the name repeats information on significant features of the basidiocarp when fresh: "*Pileo paulum crasso, translucido . . . cute adhaerente, non facile discernibili, glabra, subrugosa, non striata, in medio ochraceo, in centro ex brunneo rufo, margine ex albo cremeo. Stipite . . . toto cremeo, durissimo . . . Lamellis . . . rigidis, fragilibus, ex cremeo albidis. Carne durissima, fragillima, alba, odore cancrino, subfoetida, miti. Sporis in cumulo albis . . .*" Heim incorrectly reported cystidia to be absent.

Russula hoehnelii Sing., Pap. Michigan Acad. Sci. 32: 110. 1948.—TYPE: "In terra. Tjibodas, Java, F. v. Höhnel." (holotype: FH!). Figs. 3–5.

Spores $5.5\text{--}6.8 \times 4.1\text{--}5.3 \mu\text{m}$, broadly elliptic, elliptic, or obovate; ornamentation $0.2\text{--}0.3 \mu\text{m}$ high, of variously sized warts which are usually isolated, rarely connected by fine lines, never forming a reticulum; suprahilar area a plage. Basidia $36\text{--}48 \times 5\text{--}8 \mu\text{m}$, clavate, 4-spored. Hymenial pseudocystidia $40\text{--}56 \times 4\text{--}8 \mu\text{m}$, clavate, usually rounded apically, but sometimes appendiculate or capitulate,



FIGS. 1–5. *Russula*. 1–2. *R. archaea* (*Heim H49*, holotype). 1. Spores, $\times 2100$. 2. Hymenial pseudocystidia, $\times 570$. 3–5. *R. hoehnelii* (*von Höhnel s.n.*, holotype). 3. Spores, $\times 2100$. 4. Cheiloleptocystidia, $\times 570$. 5. Hymenial pseudocystidia, $\times 570$.

empty or with scattered yellowish refractive granules, arising in the subhymenium, projecting not at all or only up to 7 μm beyond the basidioles, common on the lamellar faces, rare on the edges. Cheiloleptocystidia 16–40 \times 3–7 μm , cylindrical to clavate, sometimes curved or slightly sinuous, hyaline, often arising from a short-cylindrical to globose cell or chain of such cells, abundant. Subhymenium 27–40 μm thick, prosenchymatous, the hyphae loosely interwoven and their cells mostly short. Trama lacking vascular hyphae. Pileus cuticle lacking vascular hyphae and pseudocystidia, of three layers: (1) a basal layer 13–40 μm thick of generally horizontally oriented, nongelatinous hyphae 1–7 μm broad indistinguishable from the connective hyphae of the trama below (this layer could just as well be considered part of the trama; in areas between the pileus warts it is the only part of the cuticle present); (2) a layer 47–133 μm thick of compactly interwoven, nongelatinous, yellowish hyphae mostly 3–8 μm broad, but with some inflated cells up to 16 μm broad; this layer forms the most conspicuous part of the cuticle, and the warts, and its hyphae give rise to (3) ascendant to erect, nongelatinous, unbranched, aseptate, hyaline hyphal ends, which are 22–93 \times 2–8 μm , have rounded apices, and may be variously enlarged or constricted along their lengths; these hyphal ends are absent or matted down in some places, but in others may form a very loosely organized trichoderm. Stipe cuticle absent in some places where tramal sphaerocysts appear at the stipe surface, elsewhere a layer 6–20 μm thick of interwoven, nongelatinous, yellowish to hyaline hyphae 1–10 μm broad from which arise ascendant to erect hyphal ends similar to those of the pileus surface, but here not dense enough to form a trichoderm.

Solitary on soil.

SPECIMEN EXAMINED. Java. Tjibodas, 1908, *von Höhnelt s.n.* (FH, holotype of *R. hoehnelii* Sing.).

The collection cited is a single dried basidiocarp in good condition. Singer's original description provides information on significant macroscopic characters as follows: "Pileo flavido vel pallide brunneo-ochraceo in maturis . . . sicco, verruculoso, verrucis densioribus colorque saturatiore centrum versus ubi superficies subintegra videtur, interdum subsquamoso-rupto, rugoso-costato supra dorsum lamellarum . . . Lamellis ochraceo-cremeis, anastomosis paucis transversalibus connexis, aequalibus vel subaequalibus, simplicibus . . . admodum distantibus . . . adnexo-attenuatis vel subdecurrentibus . . . Stipite concolori, basin versus acuminato-attenuato, sublevi, nudo, glabro vel subglabro . . ."

Subsection *Archaeinae* was established by Heim (1938), who gave as its key characters the relatively few, narrow, thick, triangular lamellae accompanied by lamellulae; the white, unchanging trama with mild taste; and the small spores (up to 7 μm long) with scarcely distinct amyloid warts. Heim placed the taxon in "*Russula Compactae*" and first included only *R. archaea* in it. He later (Heim 1943) added *R. fragilissima* Heim from French Guinea in western Africa and, despite having previously described the lamellae of *R. archaea* as "adnatis descendentibus sed non decurrentibus," emphasized the relatively few, decurrent lamellae and the brittle (although hard) trama as the characters of the two species that united them as the *Archaeinae*. Singer (1948, 1952, 1955) enlarged the subsection to include also *R. hoehnelii*; *R. earlei*; *R. dennisii* Sing., a new species "ad int." based on Trinidad material; and *R. immaculata* (Beeli) Dennis ex Sing. from the Belgian Congo. Romagnesi (1968) added *R. camarophylla* Romag. from east-central France. Most

recently Singer (1986; see also Singer & Araujo 1983), while recognizing the *Archaeinae* at the rank of section, included only *R. archaea* in it. *Russula earlei* and *R. hoehnelii* were transferred to sect. *Ingratae* subsect. *Fistulosinae*; *R. camarophylla* and, with uncertainty, *R. immaculata* were assigned to sect. *Delicoarchaeae*; and *R. dennisii* and *R. fragilissima* went unmentioned.

Thus, the history of the *Archaeinae* illustrates well the taxonomic instability that is common at the infrageneric level in *Russula*, and that results primarily, I believe, from the generic subdivisions being poorly defined and differentiated. I propose that this particular taxon be maintained with the following rank and circumscription.

Russula sect. **Archaeinae** (Heim ex Romag.) Sing., Agaricales, 4th ed., 812. 1986. *Russula* subsect. *Archaeinae* Heim, Lactario-russulés Madagascar 68. 1938, without Latin description. *Russula* subsect. *Archaeinae* Heim ex Romag., Bull. Mens. Soc. Linn. Lyon 37: 105. 1968. [Romagnesi actually referred to the taxon using the French word "section." I interpret his discussion to indicate, however, that he did not intend to alter the rank of Heim's "sous-section" of the *Compactae*, rather only to validate the name by providing a Latin translation of the original French description.]—
TYPE: *Russula archaea* Heim.

Basidiocarps hard, brittle, not changing color when cut or bruised, but sometimes staining reddish brown during development. Pileus not sulcate-striate marginally; cuticle thin, viscid when wet, but soon dry and dull, not separable or separable only at the pileus edge, yellowish white to moderate orange yellow or light yellowish brown; trama neither acrid nor bitter, yellowish white to pale orange yellow. Lamellae thick, acute in front, adnate to slightly decurrent, equal or unequal and then the lamellulae neither regularly alternating with the lamellae nor arranged in tiers, distant, at most slightly acrid or bitter, yellowish white to moderate orange yellow or light yellowish brown. Stipe yellowish white to moderate orange yellow or light yellowish brown.

Color reactions on the pileus trama: SV colorless to pale purplish gray; 10% FeSO₄ pale yellowish pink to light grayish reddish brown; 2% phenol moderate reddish brown; formalin colorless; guaiac slowly grayish olive.

Spores white to yellowish white in mass, ca $7 \times 5 \mu\text{m}$ or smaller; ornamentation of low, mostly isolated warts, never forming even a partial reticulum, the spores sometimes almost smooth; suprahilar area a plage. Hymenial pseudocystidia common, but sometimes inconspicuous because of their narrow width, sparse SV-contents, and little or no projection. Trama lacking vascular hyphae. Pileus cuticle embedded in a gelatinous matrix, not distinctly sublayered (an epicutal trichoderm poorly formed if present at all), lacking well-differentiated vascular hyphae and pseudocystidia.

I presently recognize four remarkably similar species as belonging to the section; they may be distinguished as follows:

1. Subhymenium prosenchymatous, its short-celled, much-branched hyphae dense just beneath the basidia and loosely interwoven elsewhere, prominently traversed by the hymenial pseudocystidia that arise in the subhymenium or at the outer edge of the trama; connective hyphae of the pileus trama often thick-walled, the walls up to $3 \mu\text{m}$ thick and sometimes even occluding the lumen. *R. earlei*.
1. Subhymenium pseudoparenchymatous throughout, the hymenial pseudocystidia inconspicuously arising at various levels in it; connective hyphae of the pileus trama thin-walled.

- | | |
|--|--------------------------|
| 2. Pileus warty except on the disc; lamellae equal, not forked. | <i>R. hoehnelii</i> . |
| 2. Pileus smooth or irregularly cracked; lamellae unequal (the lamellulae common) and occasionally forked. | |
| 3. Pileus thin, translucent-striate; odor crablike, almost fetid. | <i>R. archaea</i> . |
| 3. Pileus thick, opaque, not striate; odor slight, breadlike. | <i>R. camarophylla</i> . |

Singer (1986; Singer & Araujo 1983) differentiated sect. *Delicoarchaeae*, with cystidia present, from sect. *Archaeinae*, lacking cystidia, the latter characterization being based on Heim's original description of *R. archaea*, which is erroneous on this point. Singer suggested that if cystidia prove to be present in this species, the two sections might be combined (but in such a merger the epithet *Archaeinae* would not have priority at the sectional rank as he stated). However, the species that he included in the *Delicoarchaeae*, except for *R. camarophylla*, do not fit the definition of the *Archaeinae* accepted here.

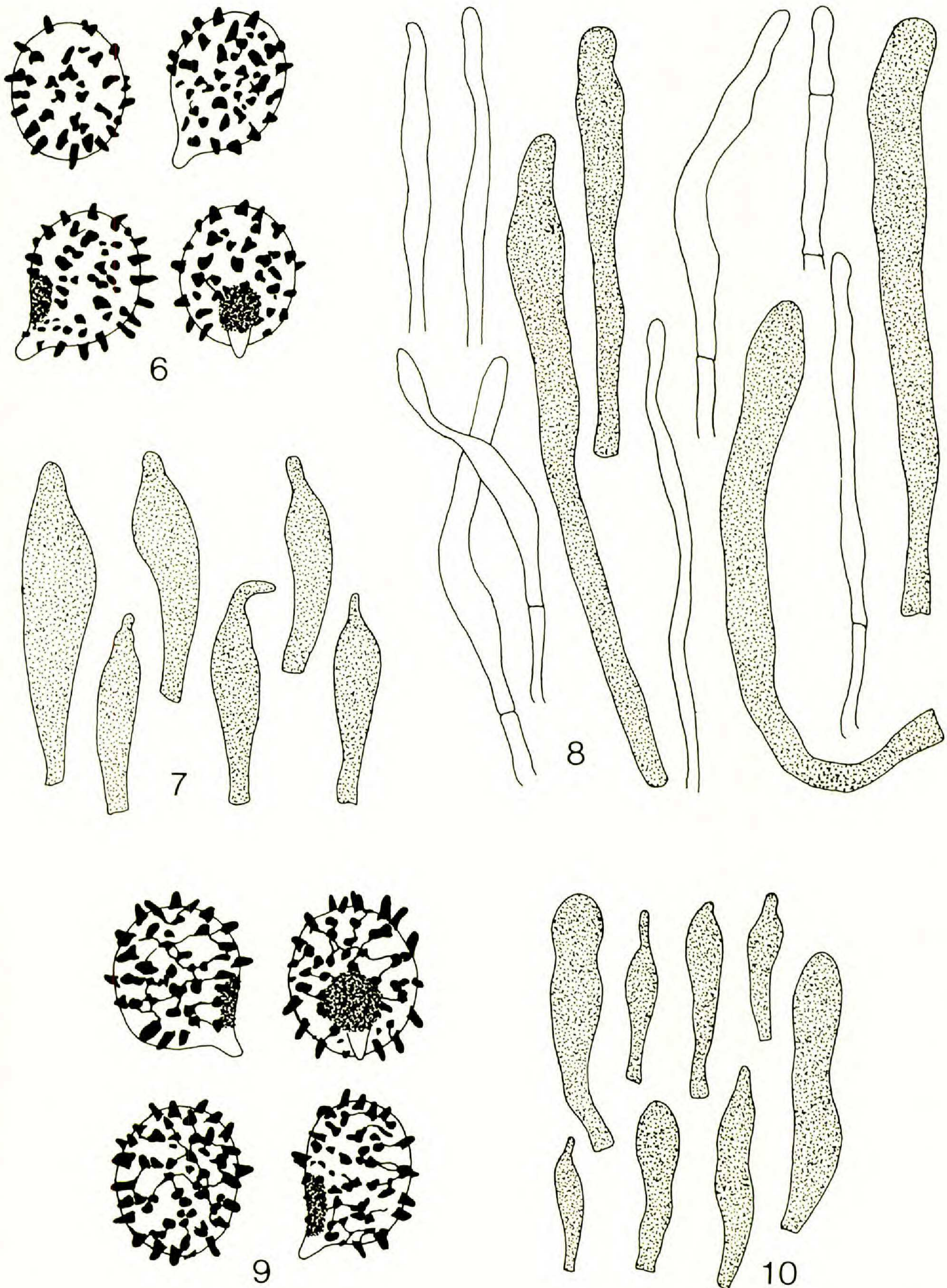
MORE ON WHITE-CAPPED RUSSULAS

Since describing, or redescribing, *R. anomala* Pk. and other russulas that have been confused with *R. albida* Pk. (Shaffer 1989), I have studied type material, from NYS, of both of these species names. The holotype of the former ("Damp ground under trees. Port Jefferson. July.") agrees, insofar as can be determined, with my recent description of the species, which was based on Michigan collections, except that the pilei tend to be more conspicuously striate on the very margin and the basidiocarps are definitely smaller. As dried, the pilei are ca 23 mm broad and the stipes ca 25 mm long; Peck's (1897) measurements on fresh material were 1–1.5 mm for both dimensions. Figures 6–8 illustrate microscopic features of the holotype.

The collection of *R. albida* marked "TYPE" evidently represents two gatherings, for Peck's label gives as the locality "Sandlake -2 Farlin." (I could not determine the identity of Farlin.) Inside the box are a loose scrap of paper with "Russula albida S L July" written on it, several loose whole and part basidiocarps, and two others strapped to pieces of heavy paper marked "2." The fungal material all represents the same species, and it does give a red macrochemical reaction with sulfovanillin, as Singer (1947) first found. Pileus and stipe surfaces of dried basidiocarps, when SV was applied, quickly turned moderate red, and later became vivid red and eventually deep red. Microscopic features that could be determined are as follows.

Russula albida Pk., New York State Mus. Bull. 1(2): 10. 1888.—TYPE: "Woods. Sandlake. July and August." (lectotype, here designated following a specimen annotation by Gerald F. Bills: NYS!). Figs. 9–10.

Spores $6.6\text{--}9.3 \times 5.7\text{--}7.3 \mu\text{m}$, usually broadly elliptic to broadly obovate, rarely subglobose; ornamentation up to $0.6\text{--}1.2 \mu\text{m}$ high, of hemispheric to subcylindric or bluntly conic warts, these occasionally clustered or aligned and sometimes with enough connectives to form a partial or complete reticulum; suprahilar area with low, diffuse, uneven ornamentation. Basidia $34\text{--}50 \times 8\text{--}12 \mu\text{m}$, clavate, 4-spored. Hymenial pseudocystidia $45\text{--}81 \times 10\text{--}16 \mu\text{m}$, clavate to fusoid-clavate, rounded, subacute, mucronate, or short-appendiculate apically, with SV- granular to acicular contents (which sometimes turn yellowish brown to brownish orange in SV); arising in the subhymenium or at the outer edge of the trama, not projecting or projecting up to $15 \mu\text{m}$ beyond the basidioles, abundant. Trama apparently lacking vascular hyphae



FIGS. 6–10. *Russula anomala* and *R. albida*. *R. anomala* (Peck s.n., holotype): 6. Spores, $\times 2300$. 7. Hymenial pseudocystidia, $\times 570$. 8. Connective hyphal ends and pseudocystidia from the pileus cuticle, $\times 825$. *R. albida* (Peck s.n., lectotype): 9. Spores, $\times 2300$. 10. Hymenial pseudocystidia, $\times 570$.

(at least if these present, not SV+ and lacking conspicuous granular contents). Pileus subcutis pseudoparenchymatous, lacking vascular hyphae. Pileus epicutis lacking a gelatinous matrix, vascular elements, and primordial hyphae.

In woods.

SPECIMENS EXAMINED. U.S.A. New York. Rensselaer Co.: Sand Lake and Farlin, July, Peck s.n. (NYS, lectotype of *R. albida* Pk.).

Russula albida awaits modern redescription from fresh material.

TWO YELLOW-CAPPED SPECIES OF SECT. RUSSULA

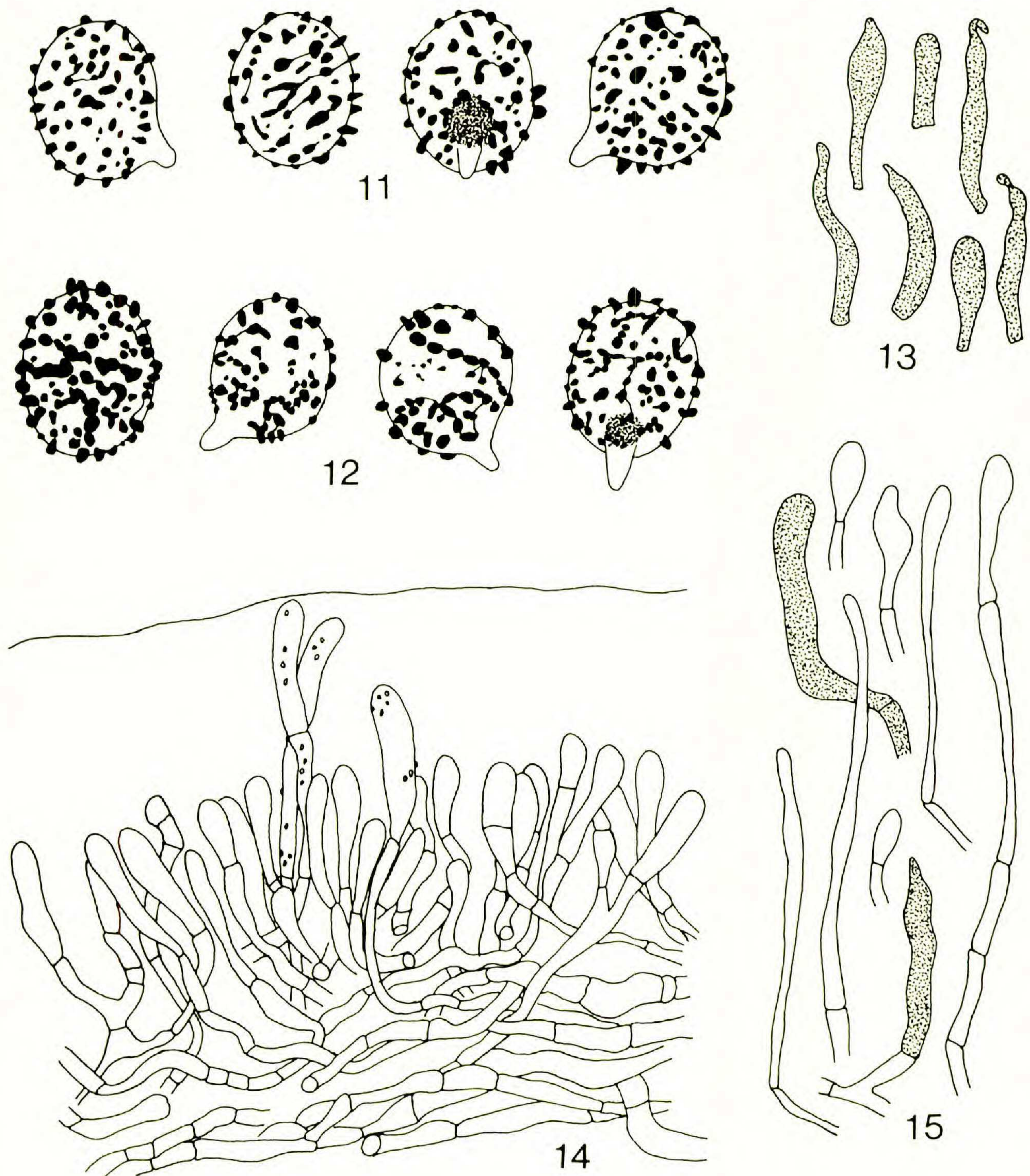
Two distinctive russulas with yellow caps have appeared in my own and others' collections from a wide geographic area over the years, and now seem well enough known from North American specimens to put on record.

Russula lutea (Huds.: Fr.) S. F. Gray, Nat. Arr. Brit. Pl. 1: 618. 1821. *Agaricus luteus* Huds., Fl. Angl., ed. 2, 611. 1778. *A. luteus* Huds.: Fr., Syst. Myc. 1: 55. 1821. *Russulina lutea* (Huds.: Fr.) Schroet. in Cohn, Krypt.-Fl. Schles. 3(1): 552. 1889. *Russula chamaeleontina* var. *lutea* (Huds.: Fr.) Melzer & Zvara, Arch. Přírodov. Výzk. Čech. 17(4): 89. 1927.—TYPE: "Habitat in pratis et pascuis sub arboribus, et nemorosis. VIII-X." Figs. 11-15.

Pileus 2.3-6 cm broad, when young deeply convex with an incurved margin, expanding through convex to plane and then sometimes depressed centrally or subumbonate or both, in age irregularly concave or subinfundibuliform, not striate when young, becoming striate, at times only faintly so, 1-4 mm from the edge inward; cuticle thin, viscid when moist, sometimes dry, shiny, glabrous, separable $\frac{1}{3}$ - $\frac{2}{3}$ the pileus radius, tasteless, light to vivid yellow or brilliant to strong orange yellow, sometimes darker centrally and paler marginally, occasionally fading in age; trama thin (1-3 mm thick at mid-radius), soft-brittle, with a slight, nondescript taste and no appreciable odor, sometimes tinged yellow just beneath the cuticle, otherwise white, unchanging when injured, but moderate yellow around the larval channels. Lamellae moderately broad (3-6 mm broad), flexible to brittle, equal, rounded in front, adnexed to adnate, close to subdistant, sometimes forked at or near the stipe, intervenose, at times only faintly so, entire, with a slight, nondescript taste, pale yellow when young, becoming light yellow or pale to light orange yellow, unchanging when injured. Stipe 1.7-6 cm long, 5-14 mm thick, subequal, or enlarging or tapering to the base, dry, dull, minutely felted, longitudinally rugulose, solid at first, becoming stuffed and eventually hollow, whitish, at times stained pale to moderate yellow near the base, but unchanging when injured.

Color reactions on the stipe surface: SV bluish gray; 10% FeSO₄ pale yellowish pink; 2% phenol dark grayish reddish brown; formalin colorless, pale pink, or pale orange; guaiac quickly moderate bluish green to dark green.

Spores moderate orange yellow (M&P 10I6) in mass, 5.9-9.0 × 4.9-7.1 μm, usually broadly elliptic to broadly obovate, rarely subglobose; ornamentation of bluntly cylindrical to conic warts and short ridges, both up to 0.3-0.7 (-1.0) μm high, and sometimes a few connectives, occasionally forming a partial reticulum, never a complete one; suprahilar area with low, diffuse, uneven ornamentation. Basidia 32-43 × 9-15 μm, clavate, usually 4-spored, occasionally 2-spored. Hymenial pseudocystidia 36-73 × 3-10 μm, usually fusiform, clavate, or fusoid-ventricose, occasionally filamentous, often appendiculate or subcapitate, otherwise rounded apically, SV- or SV+, arising in the subhymenium, projecting up to 28 μm beyond the basidioles, abundant. Subhymenium 34-40 μm thick, pseudoparenchymatous.



FIGS. 11–15. *Russula lutea* (11, 13–15 from *Shaffer 1503*; 12 from *Shaffer 6052*). 11–12. Spores, $\times 2300$. 13. Hymenial pseudocystidia, $\times 570$. 14. Pileus epicutis and upper portion of the subcutis, $\times 825$ (the horizontal line represents the top of the gelatinous matrix). 15. Hyphal ends and pseudocystidia from the stipe surface, $\times 825$.

Trama lacking vascular hyphae. Pileus subcutis 45–68 μm thick, of horizontal- to ascending-interwoven, nongelatinous or gelatinous, orange yellow (from an intracellular pigment) connective hyphae 1–4 μm broad, lacking vascular hyphae. Pileus epicutis 23–57 μm thick, embedded in a gelatinous matrix which may considerably overtop the hyphae, a trichoderm mainly of subgelatinous or gelatinous, mostly 1–2-septate, rarely branched, hyaline to pale yellow, cylindrical to clavate connective hyphal ends 1–7 μm broad, also with common, mostly 1–3-septate, unbranched, hyaline, incrusting hyphae 2–6 μm broad and sometimes having SV-granular contents, these primordial hyphae up to 80 μm long and repent or project-

ing into or even beyond the gelatinous matrix, lacking pseudocystidia. Stipe surface layer of longitudinal-interwoven, nongelatinous, hyaline to yellowish connective hyphae 1–4 μm broad, many of which are incrustated with colorless platelets and droplets, also with scattered SV– granular vascular hyphae and pseudocystidia 3–7 μm broad, the hyphal ends of both types sometimes projecting as hairs.

Solitary, scattered, or gregarious on humus in deciduous and deciduous-coniferous woods.

SPECIMENS EXAMINED. CANADA. Ontario: Parry Sound Co.: Indian Point region, 11 Aug 1920, *Burlingham* (*Kelly* 864); Magnetewan, 4 Sep 1921, *Kelly* 1062. Québec: Montmorency Co.: St-François d'Orléans, 15 Aug 1967, *Shaffer* 5880.—U.S.A. Maine: Cumberland Co.: Raymond, 9 Aug 1940, *Rea* H.992. Michigan: Cheboygan Co.: Colonial Point, Burt Lake, 16 Jul 1957, *Shaffer* 1540; Mud Lake, 12 Jul 1957, *Shaffer* 1480, and 5 Aug 1971, *Shaffer* 6816; W of Topinabee, 14 Jul 1957, *Shaffer* 1503. Chippewa Co.: Tahquamenon Falls State Park (lower falls area), 22 Jul 1968, *Shaffer* 6052. Emmet Co.: Cross Village, 20 Jul 1959, *Shaffer* 2179; W of Mackinaw City, 15 Jul 1957, *Shaffer* 1525 and *Shaffer* 1526. Luce Co.: Tahquamenon Falls State Park (upper falls area), 6 Aug 1951, *Smith* 37521. Mackinac Co.: Bois Blanc Island, 27 Jul 1947, *Smith* 26045. Ogemaw Co.: Rifle River, near Lupton, 28 Sep 1961, *Shaffer* 3640. Montana: Lake Co.: Yellow Bay, Flathead Lake, 18 Jul 1968, *Bennett* 462; Petersen Creek Trail, Swan Lake, 30 Jul 1968, *Bennett* 510. Vermont. Windham Co.: Newfane Hill, 1920, *Burlingham* (*Kelly* 628).

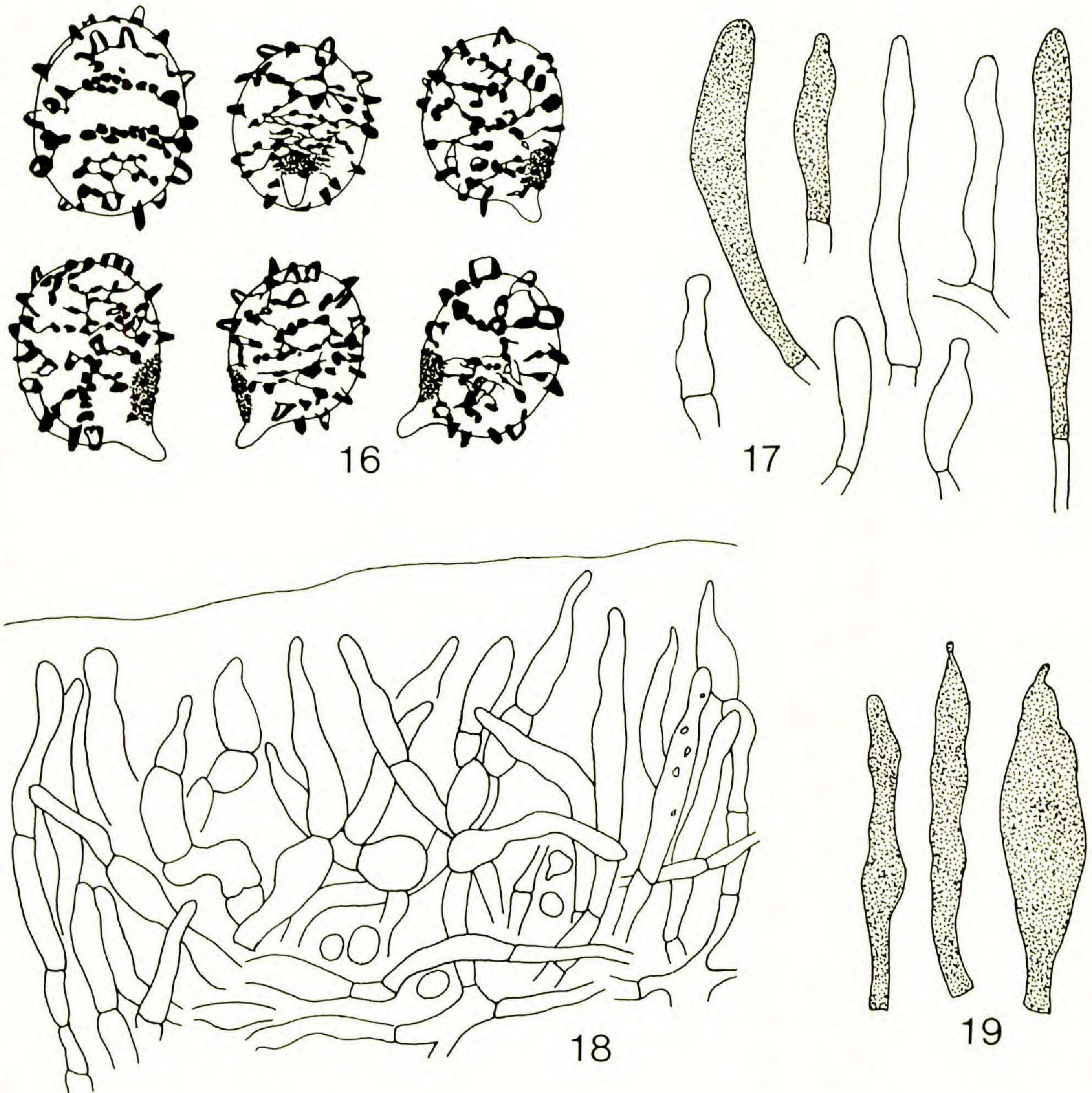
The incrustations on the primordial hyphae of the pileus epicutis take up fuchsin, but are not acid fast; those on the hyphae of the stipe surface differ in that they disappear in fuchsin.

Russula lutea belongs in subsect. *Chamaeleontinae* of Singer's (1986) classification. Romagnesi (1967), who also recognized this group, used the epithet *lutea* for a yellow-capped form of *R. chamaeleontina* Fr., and the name *R. vitellina* (Pers.) S. F. Gray for a closely related yellow-capped species. His separations relied heavily on distinctive odors, none of which I have detected in North American material. The species here described is similar to *R. vitellina* in Romagnesi's sense, but the odor of the basidiocarps does not become "aigre, presque vinaigrée, or rapellant la moutarde, assez désagréable" as they begin to decay. If *R. lutea* and *R. vitellina* are considered synonyms, the former name has priority.

Russula xantho Shaffer, sp. nov.—TYPE: west of Mackinaw City, Emmet Co., Michigan, 29 Jul 1968, *Shaffer* 6067 (holotype: MICH!). Figs. 16–19.

Fructificatio mediocris. Pileus margine subtiliter striatus; cuticula glabra, insapora, lutea, ad centrum aurantiaca; trama firma fragilisque, sapore non acro, odore indistincto, albida vel luteola, nonnunquam lutea vel aurantiaca sub cuticula, tarde cinerascens, ope sulfovanillinae incolorata. Lamellae fragiles, versus ambitum rotundatae, adnatae vel adnexae, confertae, sapore indistincto, stramineae, nonnunquam luteomarginatae, nonnunquam leviter cinerascens. Stipes totus albidus vel supra luteus, leviter cinerascens. Sporae in cumulo luteolae, 6.8–9.7 (–10.7) \times 6.3–7.9 μm (ornamentatione exclusa), verrucis et cristis usque ad 0.7–1.2 μm altis et connectivis, ornamentatione reticulum inchoatum vel integrum saepe formanti. Subcutis pilei ex hyphis conjunctivis intertextis et hyphis vascularibus rarissimis constans. Epicutis pilei trichodermium formans, ex hyphis conjunctivis cellulis interdum inflatis vel cystidioideis et pseudocystidiis rarissimis constans.

Pileus 4.5–8 cm broad, subglobose when young, expanding to deeply pulvinate and eventually plano-convex with a depressed disc, becoming finely tuberculate-striate 3–6 mm from the edge inward; cuticle thin, viscid to almost dry, shiny to



FIGS. 16–19. *Russula xantho* (Shaffer 6067, holotype). 16. Spores, $\times 2300$. 17. Hyphal ends and pseudocystidia from the stipe surface, $\times 825$. 18. Pileus epicutis and upper portion of subcutis, $\times 825$ (the horizontal line represents the top of the gelatinous matrix). 19. Hymenial pseudocystidia, $\times 570$.

subshiny, glabrous, separable $\frac{2}{3}$ the pileus radius, tasteless, when young unevenly deep orange, strong orange yellow, and vivid yellow overall, when mature deep orange centrally and vivid to strong yellow marginally; trama 2–3 mm thick at mid-radius, firm-brittle, with a faintly spermatic taste and a slight, nondescript odor, sometimes tinged yellow to orange just beneath the cuticle, otherwise buffy white to pale yellow, slowly (e.g., overnight) cinerescens where cut. Lamellae 6–8 mm broad, brittle, equal, rounded in front, adnate to adnexed, close, occasionally forked at or near the stipe, intervenose, entire to finely lacerate, with a mild, nondescript taste, pale yellow at first, becoming light yellow, sometimes edged with strong yellow, unchanged or slightly dingy in age. Stipe 4–9 cm long, 12–20 mm thick, equal or enlarging to the base, dry, dull, glabrous, longitudinally rugulose, stuffed, buffy white below and strong yellow above (i.e., on the portion originally in contact with the lamellar edges), or buffy white overall, slightly cinerescens in age or when handled.

Color reactions on the pileus trama: SV colorless; 10% FeSO_4 grayish yellowish

pink; 2% phenol dark grayish reddish brown; formalin colorless; guaiac slowly greenish gray.

Spores light orange yellow (M&P 9G5) in mass; $6.8\text{--}9.7$ (-10.7) \times $6.3\text{--}7.9$ μm , usually broadly elliptic to broadly obovate, occasionally subglobose; ornamentation of warts and ridges, both up to $0.7\text{--}1.2$ μm high, and connectives, often forming a partial or complete reticulum; suprahilar area with low ornamentation varying from closely spaced warts, ridges, and connectives to an uneven, diffuse patch, and in most cases appearing as strongly amyloid as the ornamentation on the rest of the spore wall. Basidia $25\text{--}59 \times 8\text{--}15$ μm , clavate, 4- or rarely 2-spored. Hymenial pseudocystidia $36\text{--}86 \times 6\text{--}15$ μm , usually fusiform, sometimes fusoid-clavate, clavate, lanceolate, or even subcylindric, rounded to acute or capitellate, mucronate, or appendiculate apically, empty or with weakly SV+ contents, arising in the subhymenium usually at lower levels than the basidia, projecting up to 40 μm beyond the basidioles, common to abundant. Lamellar edges sometimes bulbous in section and then with few or new basidia, the component hyphal ends sometimes relatively undifferentiated in shape and contents, but usually with short subapical cells and terminated by either a pseudocystidium, whose size generally falls in the lower part of the range given above, or a leptocystidium, which may be clavate, fusoid-ventricose, tapered, fusiform, or irregular in shape. Subhymenium $23\text{--}40$ μm thick, pseudoparenchymatous. Trama with occasional, SV- glassy vascular hyphae, and rare, inconspicuous, SV- or weakly SV+ granular vascular hyphae. Pileus subcutis $135\text{--}270$ μm thick, dense, of horizontal-interwoven, nongelatinous connective hyphae $1\text{--}5$ μm broad, these hyphae with diffuse orange yellow pigment, also with rare SV- glassy vascular hyphae $1\text{--}5$ μm broad. Pileus epicutis $50\text{--}60$ μm thick, embedded in a gelatinous matrix, a well-formed trichoderm of nongelatinous, septate, branched connective hyphae whose subapical cells may be inflated to various degrees (up to 9 μm broad) and whose apical cell is sometimes cystidioid in shape (tapered, lanceolate, fusiform, oval, clavate, narrowly fusoid-ventricose), at times capitellate, and occasionally with scattered small refractive bodies; also with rare elongate-clavate pseudocystidia $4\text{--}5$ μm broad which arise usually in the subcutis and have sparse refractive contents that are at most weakly SV+. Stipe surface layer of longitudinal-interwoven, nongelatinous, hyaline to yellowish connective hyphae $1\text{--}5$ μm broad whose cystidioid terminal cells often project from the stipe surface, may be scattered or clustered, and may be SV-, clavate pseudocystidia; also with SV- vascular hyphal ends $3\text{--}7$ μm broad which grade into the pseudocystidia.

Solitary to gregarious on humus usually in deciduous (e.g., beech-maple) woods.

SPECIMENS EXAMINED: CANADA. Nova Scotia: Kings Co.: Harrington Woods, Kentville, 3 Aug 1972, *Harrison 11683*.—U.S.A. Michigan: Cheboygan Co.: Carp Creek Gorge, 7 Aug 1961, *Charlton G294*, and 1 Aug 1973, *Shaffer 6955*. Emmet Co.: W of Mackinaw City, 25 Jul 1949, *Harding s.n.* and 29 Jul 1968, *Shaffer 6067* (holotype of *R. xantho* Shaffer). Wisconsin: Dunn Co.: Devil's Punch Bowl, south of Menominee, 4 Jul 1971, *Mazzer 6542*.

The species epithet, from Greek, refers to the pileus cuticular color; Xantho was the golden-haired daughter of the sea-god Nereus. By some American mycologists this species has been called *R. aurata* (With.) Fr., to which it is close. However, *R. aurata* as described by Romagnesi (1967), and studied by me in Europe (e.g., *Shaffer 4033, 4069, 4235, and 4595*), has pilei that are partly or entirely dark reddish

orange to dark grayish reddish brown or grayish red. Often they are also partly strong orange-yellow to strong yellow, but, even when mostly these colors, they have small reddish areas as shown in Schaeffer's (1952) pl. 11, fig. 37. The slight cinerescence of the basidiocarp and the presence of a few inconspicuous pseudocystidia in the pileus cuticle, neither mentioned by Romagnesi for *R. aurata*, may be other, minor differences. Schaeffer, however, described the trama of this species as "etwas schmutzend." The yellow to orange tinge of the pileus trama just beneath the cuticle, the strong yellow edging of the lamellae, and the strong yellow coloration on the stipe have sometimes been emphasized as diagnostic characteristics of *R. aurata*, but are actually inconstant in both this species and *R. xantho*.

Russula aurata and its allies have been variously placed within sect. *Russula*, most recently by Singer (1986) in subsect. *Firmiores*.

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